CareBase: A Reference Base for Nursing

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Due to the lack of generally accepted nursing classifications and standards in Germany the introduction of nursing information systems for planning and documentation of care is a very time consuming process since the classifications and standards must be defined locally to adjust the systems. At the University Hospital Freiburg a nursing reference system was developed to collect this knowledge, make it available for easy reference and as a source usable for the initialisation of nursing information systems to be installed in the future.

INTRODUCTION

In the past the financing of German hospitals has been purely based on the length of stay of an inpatient regardless of the diagnosis or treatment. Since the German health system reform by the "health structure law" the financing is partly based on a DRG-like system for some diagnosis/treatment combinations and still partly based on a length of stay based system taking into account now the different medical specialities. This change in the financing made it increasingly important to control the actual costs accumulated during a patient's stay. Thus more and more hospitals are installing and experimenting with ward information systems to gather as much data as possible about the patient's care and to make them available for analysis, controlling or budgeting. An additional advantage is that the data can be used as a basis for quality assurance and nursing research.

The ward information systems installed most of the time include not only medical data but nursing data as well. So they also incorporate components for care planning and documentation of care given.

One common experience in Germany is that it takes a very long time to integrate nursing information systems (NIS) into the routine work. This is due to several reasons:

- lack of "paper" experience with care planning. In some instances the introduction of the NIS was a means to the introduction of planned care.

- lack of existing, generally recommended ,and accepted classification systems for nursing diagnoses , nursing interventions and outcomes. So in order to have elements to choose from (for example to document a nursing diagnosis for a patient) it is necessary to construct individually agreed upon classification systems including taxonomies to be able to build tree structures suitable for browsing each of the above mentioned elements.

- lack of agreed upon nursing standards to help in the design of individual careplans by automating the input of common nursing knowledge and thus giving time to fit the careplan to the individual needs of the patient.

What was in most clinics of the hospital existing was a number of text documents describing various aspects of mostly nursing interventions. The documents were describing locally defined standards not structured to easily extract information needed for a NIS. So even if the available NIS might offer benefits to the routine work the effort to input the required nursing knowledge in a locally accepted way is nearly prohibitive.

At the Freiburg University Hospital - a rather large hospital with about 1800 beds - it was decided to try a different approach. Instead of starting with a care-planning and documentation system we tried to build a nursing reference base (NRB) incorporating nursing classifications and standards and common knowledge of the nursing process. This NRB can be used to create the necessary input of required parameters for NIS to be installed at a later time. The NRB will be available as a central reference service within the hospital. Thus all nursing standards can be accessed in their most up to date version at any time. Since this is a central service it will help to standardize the vocabularies and standards used at least on a hospital wide basis. The NRB can also be used as a reference for nursing students.

For the design of the system a workgroup was as-

sembled consisting of up to 6 nurses from different clinics of the hospital, 2 representatives of the nursing school, 2 informatics students and a medical informatician. Unfortunately there are no nursing informaticians in Germany because there is no such educational track available. Using the principles of participative design[1] and rapid prototyping the system *CareBase* was developed in about seven months. It consists of an entry module for input and update of the nursing knowledge and standards into the reference base and a system for comfortable browsing the reference base. The data are stored in a database common to both applications.

DATA MODEL

Nursing Classifications
The reference base has the purpose to store the knowledge of the nursing process in a structured way to make it available as a reference base and as a source for parameterizing other applications. Since there are no generally accepted German classification systems available to be used as a basis for the data model the reference base must be able to accommodate the structure of existing international nursing classifications. This is especially important since some of them are already or currently translated into the German language. It is also necessary to take into account international activities to standardize nursing

classification systems by the International Council of Nurses (ICN)[2] or the TELENURSING[3] project of the European Union. Since they analyse the structure and content of existing classifications it can be expected that similar ones will be used in Germany in the future.

General Structure of the Data Model
The elements of the nursing process represented in the model are the nursing diagnosis with goals and outcomes, further nursing interventions and the activities connected with them. Since many nursing diagnoses and interventions are related to medical diagnoses or treatments they can also be stored in the reference base. Other elements are materials associated with interventions and activities as well as the kind of trained personnel required to perform them. Since most elements are classified together with a taxonomy the hierarchical order can be stored also. In addition to specific entries every element is stored with a short definition and a descriptive text of up to 64kB length.

The system consists not only of the elements themselves but a great part of the nursing knowledge is represented in the connections between them as illustrated in figure 1. The connections can be interpreted as semantic links between the each of the elements. For every link can be stored a descriptive text of up
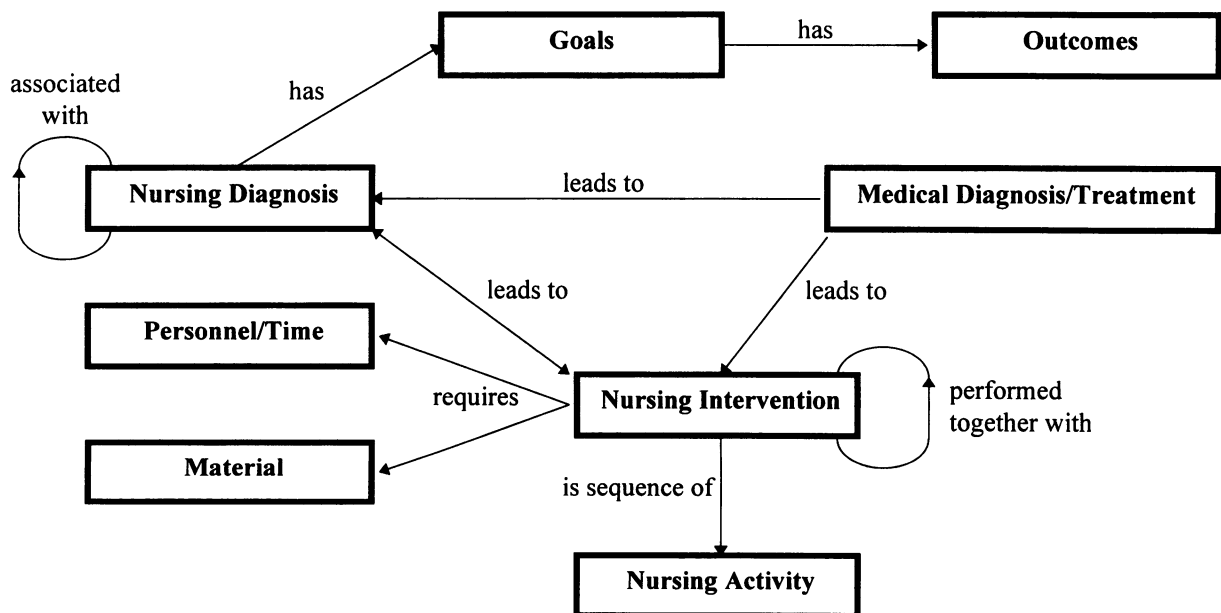

Figure 1: Relationships between the elements of the reference base

to 64kB length and a weight to characterize the strength of the link.

Nursing Diagnosis

The nursing diagnosis is one of the major components of the reference base. The structure of the data stored are also suited to accommodate nursing diagnoses as defined by the NANDA in its Swiss translation[4]. It has links to nursing interventions that are associated with the diagnosis. Since often nursing diagnoses are related to one another they have a self joining link. There is a direct 1:n relation from the nursing diagnosis to the goals associated with it. Every goal again can be linked to a number of possible outcomes of the goal.

Nursing Interventions

The structure of the nursing interventions is based on a structure similar to the Nursing Intervention Classification (NIC)[5] by McCloskey and Bulechek. So each intervention is viewed as a combination of activities. They are stored as separate entities. To facilitate later the workload management and the internal budgeting from data gathered by a NIS each intervention can be stored with the kind of trained personnel necessary and the average time required to perform it. For the same reason the materials needed for each intervention can be defined as well.

It was discussed in the beginning of the project whether to store these data together with the activities or with the interventions. It was finally decided to store the data together with the interventions. This had mainly two reasons:

1. adding up the materials needed by each activity of an intervention might not take into account the reuse of material from one activity in the next,

2. adding up the times required to perform each activity has to be adjusted for tasks that can be done in parallel to result in correct times for the interventions.

So it would be necessary to record the demands in materials and personnel separately for the activities and the interventions. Since rather the interventions than the activities performed would be used to determine the nursing workload or would be used for the internal budgeting of the hospital it was decided to only store the demands together with the interventions.

Medical Diagnosis and Treatments

The nursing process is closely related to the medical diagnosis or the treatment ordered for the patient in the way that a medical diagnosis or treatment might imply a nursing diagnosis or special nursing interventions to be performed. So these medical entities are stored in the reference base as well. They can be linked to the appropriate nursing entities to represent this knowledge.

Connecting Links

A very important part of the nursing knowledge like when or how often to perform a specific intervention is stored in the connecting links between the entities. Depending on the kind of entities being linked different data have to be stored. For example if nursing diagnoses are linked with nursing interventions it can be stored when or how often an intervention has to be performed. If nursing diagnoses are linked to themselves mainly the reason why they are related can be stored.

For the ease of the representation a weight can be stored for each entry of a specific link. Thus it is possible to define a specific nursing intervention as being required for a given nursing diagnosis or just as being sometimes helpful to be performed.

Multimedia Documents

Since there exist already many written documents in the hospital that describe various aspects of nursing interventions or other parts of the nursing process the reference base enables the storage of links to external files resembling the documents. The files are stored with short descriptions of the contents of the documents that can be used instead of the often non-descriptive filenames restricted to only a few characters. Also recorded are the names of the applications used to display the contents of the documents.

Thus there is no limitation to the kind of document being linked to an entry of the reference base. So it can be extended to include multimedia files of all kinds, e.g. images of decubiti in different stages or short movies showing how to perform an specific activity.

TECHNICAL REALISATION

Since each of the about 130 wards at the Freiburg University Hospital has a PC installed that is connected to the hospital's FDDI backbone the reference and the entry application have to be able to run on these systems using a common central database.

To limit the amount of time required to instruct the nurses in the use of the different programs necessary for their work it was decided in the past to install only MS-Windows compatible software on the systems if possible. The common user interface approach has proved itself to be successful in the past. The necessary instructions for new software could be limited to the new functionality of the programs once a working knowledge for the windows interface was existing. Often instructions are not even necessary since some applications are self-explanatory.

So the *CareBase* system was developed as MS-Windows applications using MS Visual Basic as the programming language and MS Access as the database management system (DBMS). MS Access was chosen as the DBMS since applications based on it can be easily ported to high performance server databases if need arises using the open database connectivity (ODBC) interface.

Visual Basic had already proved itself to be a quick to learn programming language for the MS-Windows environment in past projects. So it was chosen again for this system.

USER INTERFACE

Cardfile Paradigm

In the first design of the system there was a specific window for every element of the reference base. So there was a specific window for nursing diagnoses and another on the nursing interventions and so on. While this approach proved to be very flexible since several windows could be displayed concurrently, for the inexperienced user the number of different windows open at the same time was rather confusing.

So another approach was taken to limit the number of windows necessary. It was decided to display all entities in one window using a cardfile-based paradigm as shown in figure 2. By switching from one card to another the entities being displayed are switched within the same window. Within a card it is
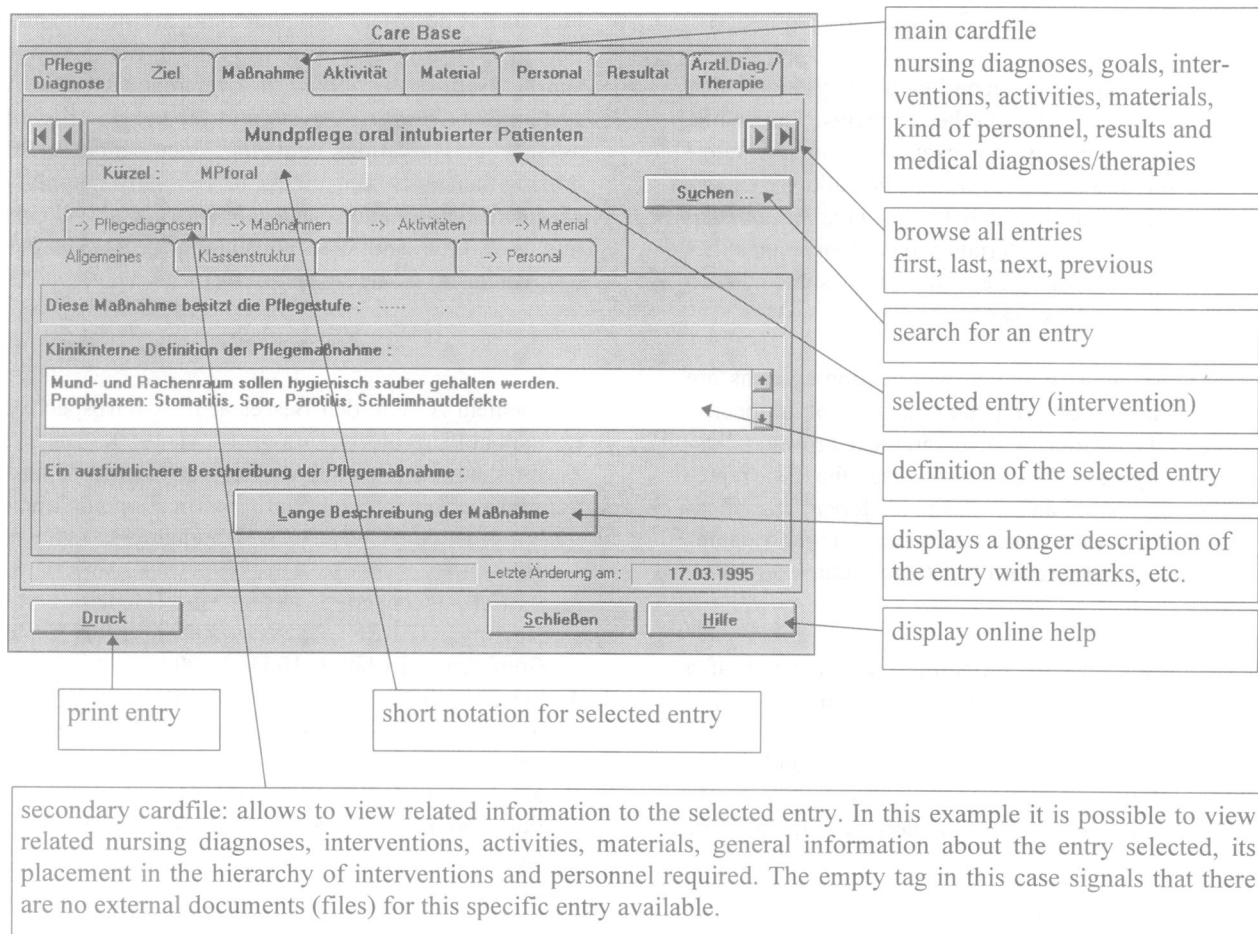

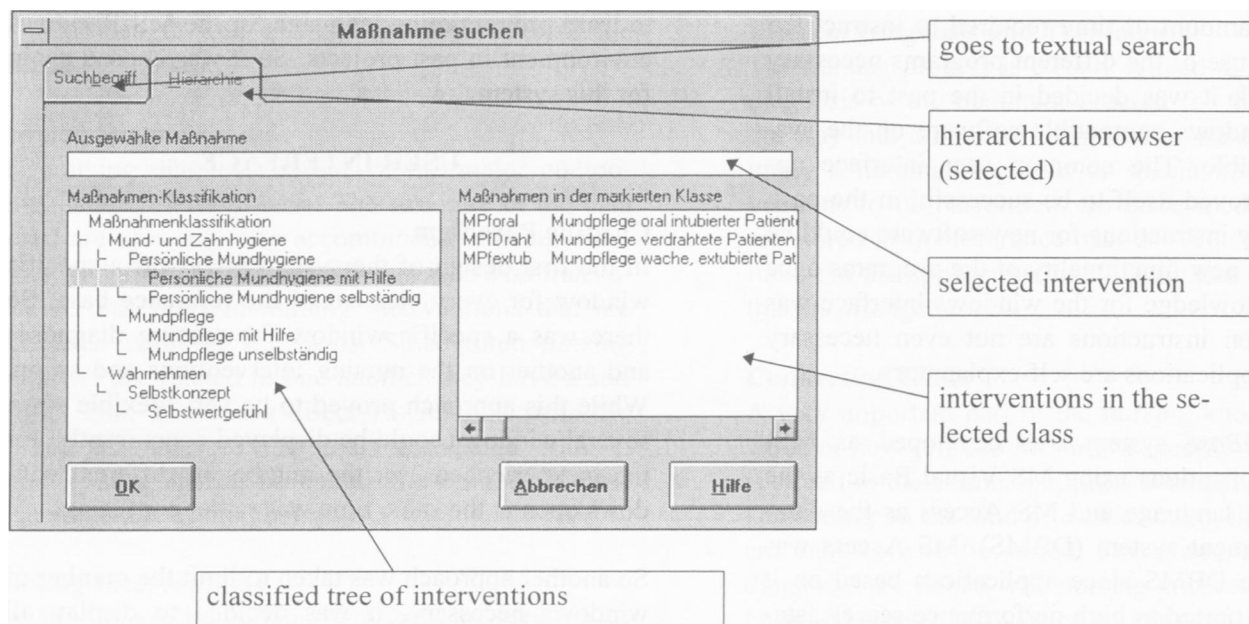**Figure 2:** Cardfile paradigm to limit number of windows neccessary

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Figure 3: Hierarchical browser for interventions

possible to change from one record to the next by the use of forward, backward, first or last record buttons.

Every card contains a second cardfile system to display the possible links to other elements. Thus while the main card displays for example a nursing intervention the secondary level cardfiles allow easy access to information related to this intervention like nursing diagnoses, materials required or even other related interventions. The system is designed like a two level hierarchy of cardfiles.

Since most larger nursing classification systems are hierarchically structured the selection of a specific record is facilitated by a hierarchical browser illustrated in figure 3. The browser uses the data representing the taxonomies of the different classifications. The use of a simple text search or short names to locate a specific record is also possible.

Printouts
Many nurses are still unfamiliar with the use of a computer as a reference media and are more familiar with printed media. So a set of standardized printouts was designed that can be printed on demand on the wards printer. Since all printouts are similar in structure the desired information can quickly be found in the printouts.

CONCLUSION

It was possible to structure important parts of the knowledge needed by nursing information systems to help in the design of careplans and the documentation of delivered care in a way that the knowledge can be usefully distributed in a reference system. A system like *CareBase* can support the construction of nursing classifications and the documentation of nursing standards. But unless in Germany generally accepted classifications and standards are available this is a time and cost consuming process every hospital has to tackle by themselves.

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